Bulletin No. 112 July 1934

PROPERTY OF THE
PENNA. STATE LIBRARY

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF INTERNAL AFFAIRS
Philip H. Dewey, Secretary

TOPOGRAPHIC AND GEOLOGIC SURVEY

George H. Ashley, State Geologist

THE WHITE CLAYS OF PENNSYLVANIA

By

Henry Leighton

CONTENTS

	Page
Introduction	1
Centre, Blair, Huntingdon and Bedford counties	1
Residual clays from the Gatesburg formation	1
Quality of the Gatesburg clays	3
Distribution and development	3
Blair property	3
Furnace Road	5
Dungarvin	5
Patton property	6
Pennington pit	6
Shoenberger pit	6
Woodbury Clay Co.	7
Fair Valley Clay Co.	8
Ore Hill	9
Baker Summit	9
Residual clays from the Oriskany sandstone	9
Alexandria Fire Clay Co.	10
Petersburg	11
Shirleysburg	11
Mount Holly Springs region, Cumberland County	12
Dillsburg region, York County	14
Narvon, Lancaster County	14
Saylorsburg region, Monroe County	17

P38.12
2.4

Digitized by the Internet Archive
in 2016 with funding from
This project is made possible by a grant from the Institute of Museum and Library Services as administered by the Pennsylvania Department of Education through the Office of Commonwealth Libraries

https://archive.org/details/whiteclaysofpenn00leig

ILLUSTRATIONS

		Page
Figure 1.	Map of part of Pennsylvania showing location of white clay deposits	ii
2.	Cross section of anticlinal valley showing relation of white clay deposits in Gatesburg sandstone	1
3.	Map showing white clay deposits in Gatesburg sandstone .	4
4.	Clay pit, Dungarvin, Huntingdon County	5
5.	Clay pit of Woodbury Clay Co., Mines Station, Blair County	8
6.	Clay pit of Fair Valley Clay Co., near Martinsburg, Blair County	8
7.	Cross section of clay pit near Alexandria, Huntingdon County	10
8.	Clay pit of Alexandria Fire Clay Co., Alexandria, Huntingdon County	10
9.	Cross section of Whitaker Clay Co. pit, Narvon, Lancaster County	15
10.	Whitaker Clay Co. mill, Narvon, Lancaster County	15
11.	Diller Clay Co. pit, Narvon, Lancaster County	16
12.	Generalized section through mine of Atlas Portland Cement Co., Saylorsburg, Monroe County	17

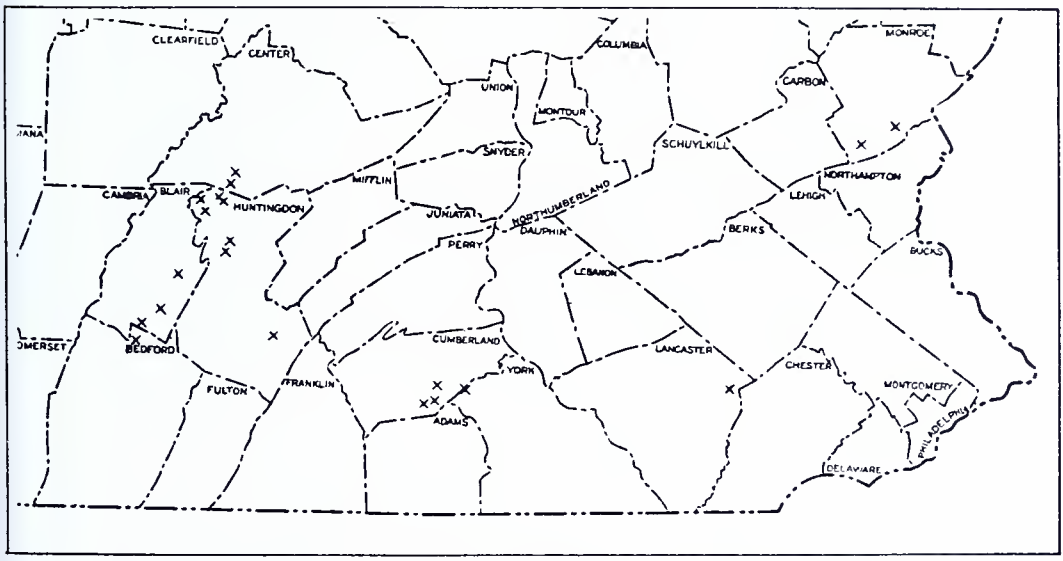

Fig. 1. Map of part of Pennsylvania showing location of white clay deposits.

INTRODUCTION

The white residual clays of Pennsylvania are derived, by weathering, from feldspathic quartzites, argillaceous and cherty limestones, and from certain schists and phyllites. These rocks are either of Upper Cambrian or of Lower Devonian age. The counties which are producing or have produced such clays are Centre, Blair, Huntingdon, Bedford, Cumberland, York, Lancaster and Monroe.

The clays are pure white to light gray and are usually accompanied by less valuable stained clays of yellow, red or even black color. The clays carry much very finely divided silica which is difficult to remove by ordinary washing processes. They also carry normal coarse sand, quartzite, and chert fragments which are easily removed.

Microscopic examination reveals that the white clays are true kaolins made up largely of kaolinite plates ranging between .001 and .016 millimeters in size. There is also much of the characteristic kaolinite fan and "worm" shaped material which is usually about .010 by .020 millimeters. The exception is the Shirleysburg clay which is made up of well aggregated masses of beidellite shreds with no true kaolinite apparent. It has more the appearance of a somewhat laminated plastic fire clay.

The physical properties indicate that these white clays are generally quite plastic but have a low green strength. Their linear air shrinkage averages around 13 per cent. They reach their maximum fire shrinkage at about 1200° to 1300° C., beyond which they are overfired. They burn to colors ranging from pure white to cream or buff.

They are used chiefly as refractory or semi-refractory cements and linings for converters and ladles in steel mills, for whitening portland cement, and, in the washed state, as a filler in the manufacture of paper. Other possible uses are in the manufacture of saggers, linoleum, rubber goods, kalsomine and other water paints, and in the manufacture of white tile, brick, and china ware.

CENTRE, BLAIR, HUNTINGDON AND BEDFORD COUNTIES.

Residual clays from the Gatesburg sandstone

The folding of the strata in the Appalachian Mountains and the subsequent erosion of the more soluble beds has left a series of flat valleys along the axes of the anticlinal folds. These valley areas are underlain by limestones, dolomites, sandstones and shales of Ordovician and Cambrian age. Lower Silurian sandstone, the Medina or Tuscarora, forms the high mountain ridges on either side. In the center of the valleys, Cambrian sandstones are exposed and in them deep weathering has produced pockets of residual iron ores and of white and varicolored residual clays. The general structure is somewhat as shown in Figure 2. The Cambrian

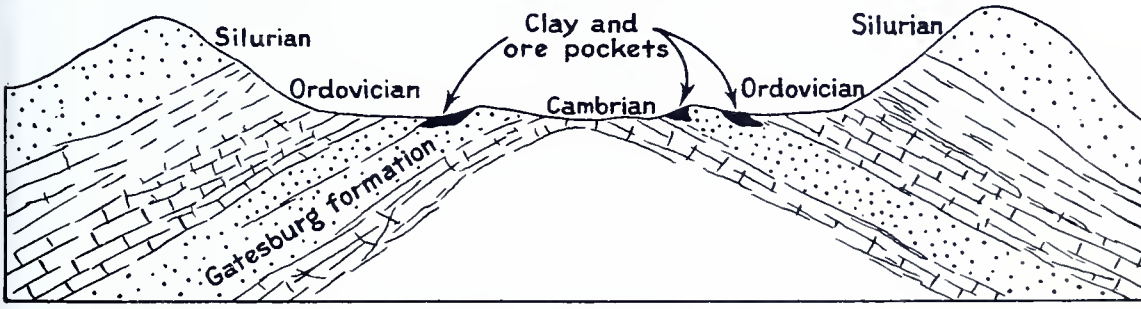

Fig. 2. Cross section of anticlinal valley showing relation of white clay deposits in Gatesburg sandstone.

strata exposed in the valleys have been subdivided as follows by Butts.[1]

Sequence of Cambrian strata

	Feet
Larke dolomite. Thick-bedded, coarse, steely blue dolomite	250
Mines dolomite. Cherty dolomite, oolitic, yields much oolitic and platy scoriaceous chert	250
Gatesburg formation. Thick-bedded, steely blue, coarsely crystalline dolomite with many interbedded quartzite layers up to ten feet thick; surface deeply covered with sand and strewn with quartzite boulders. Ore Hill member a thin-bedded blue limestone; several species of trilobites. Stacy dolomite member coarse, thick-bedded, steely blue, but without quartzite	1,750
Warrior limestone. Thick and thin-bedded blue limestone with thin siliceous shaly layers or partings. A few thin quartzite layers	250
Pleasant Hill limestone. Thick-bedded limestone at top; argillaceous, thin-bedded limestone at bottom	600
Waynesboro formation. Sandstone, conglomerate, and red and greenish shale. Underlies the basal limestones	250

The Larke, Mines, and Gatesburg formations have been classed as Lower Ordovician, Ozarkian, Canadian, or as Upper Cambrian.

Of these strata, the Gatesburg formation is the one which yields limonite iron ores and white and colored residual clays. These clays are formed by weathering of the beds of argillaceous quartzite and shaly limestone within the formation and therefore tend to follow the strike of such beds. They seem to be rather closely associated with pockets of iron ore and the whiter clays are often found around the margins of iron ore pockets. However, the white and colored clays are extremely irregular in their distribution and grade into white sands or one color grades into another either along the strike or across the bedding. Of the association of the white clay with the iron ores Moore[2] says:

> "The association of the iron and clay is believed to be due to the fact that the iron has been carried in solution by underground water and concentrated where beds of argillaceous dolomite in the sandstone have weathered out, permitting the sandstone to break down and thus create an area through which the water very readily circulates. The circulating waters remove the soluble constituents, depositing the iron oxide through replacement of the dolomite, and leaving the insoluble argillaceous materials as clay. The tendency would be to carry soluble materials toward the center of this area, where the downward circulation of the water is good, and to leave the insoluble materials around the border of what in time develops into a sort of basin. In the basin there will be more resistant masses which will not crumble down and these may be comparitively free from iron and contain some white clay. The waters entering the basin are, of course, carried away by good circulation underground, in some places being directed and aided by fractures in the strata. It is probable that faults have often directed the course of the circulating waters producing these iron and clay deposits.

---

[1]Butts, Charles. Geologic section of Blair and Huntingdon counties, central Pennsylvania. Amer. Jour. Sci., 4th ser. vol. 46, pp. 523-537, 1918.

[2]Moore, E.S. White clay deposits in central Pennsylvania. Pennsylvania Topo. and Geol. Survey, Bull. 45, p. 2, 1922.

"Observations show that the clay occurs, as a rule, along the flank of the ridge or knoll of sandstone and the presence of a deposit is often indicated by a small depression on the surface. In prospecting for clay this fact should be kept in mind, but the depressions caused by underground circulation should not be confused with stream channels, which may bear no relation to the strata giving rise to the clay. There is no doubt that some transfer of the clay occurs beneath the surface and there is a concentrating process going on in these depressions by the underground water, but the extent of the movement of the clay particles is very limited."

Quality of the Gatesburg clays

In general it may be said that the whiter grades of the clay are plastic, burning to a cream to a light buff color. Their linear air shrinkage averages around 14 per cent, the volume air shrinkage about 5 per cent. The maximum fire shrinkage is reached between 1350° C. (Cone 11) and 1430° C. (Cone 15). They fuse between 1615°C. (Cone 28) and 1650° C. (Cone 30). Their chief use is as a refractory cement for laying up silica brick, for lining converters and ladles and other purposes in steel mills, and for the manufacture of saggers. As a source of white clay for china manufacture or for filling paper they have, up to date, proved somewhat disappointing as it has been impractical to wash them free from a high percentage of very fine-grained silica which they often carry. If a successful washing process could be devised there is no doubt that the better grades could be used for these purposes.

Distribution and development

The areas of exposed Gatesburg formation and the location of the known deposits are shown on the map (Fig. 2). Three valleys show the Cambrian strata; the Nittany valley extending from Bellefonte to Birmingham, a valley between Williamsburg and Martinsburg, and a third area south from Roaring Spring. In these areas the Gatesburg formation frequently is wooded and its surface is covered with sand and quartzite fragments so that the finding of clay pockets is difficult. They have usually been found through the search in former days for iron ore. There are no doubt many masses of good white clay yet to be discovered. The known deposits will be described in order beginning in the north.

BLAIR PROPERTY. These clays lie in a wooded area of the Gatesburg sandstone between Scotia and Stormstown in Centre County, west of State College. The property can be reached by a road from Buffalo Run. It is owned by R. R. Blair of State College. Samples of the clay have been successfully washed with Dorr classifiers and a product acceptable to various industries has been produced. The property was worked in early days for iron ore, and white clay was encountered in the pits. Between 1915 and 1918 considerable prospecting was carried on in pits and shafts exposing at one point 21 feet of white clay and at another opening 14 feet of cream-colored material. No development has been done in recent years and the old exposures are obscured. Tests made by Ries[1] on these clays show that at 1150° C. (Cone 1) one sample showed 16.2 per cent absorption and another 29 per cent. The product was a cream color and not steel hard. At 1350° C. (Cone 11) the first sample showed 29 per cent absorption and at 1300° C. (Cone 9) the other sample showed 19.1 per cent absorption. Ries states that, after washing, the clay would probably be suited for use in white ware and paper manufacture. Another sample, according to Moore[2], showed at 1150° C. (Cone 1) a porosity of 46.5 per cent, was almost steel hard, and had a white color. At 1350° C. (Cone 11) its porosity was 36.4 per cent, it was steel hard, and had a cream-white color.

---

[1]Ries, H. High grade clays of the eastern United States. U.S. Geol. Surv. Bull. 708, p. 94, 1922.

[2]Moore, E. S., loc. cit. p. 3.

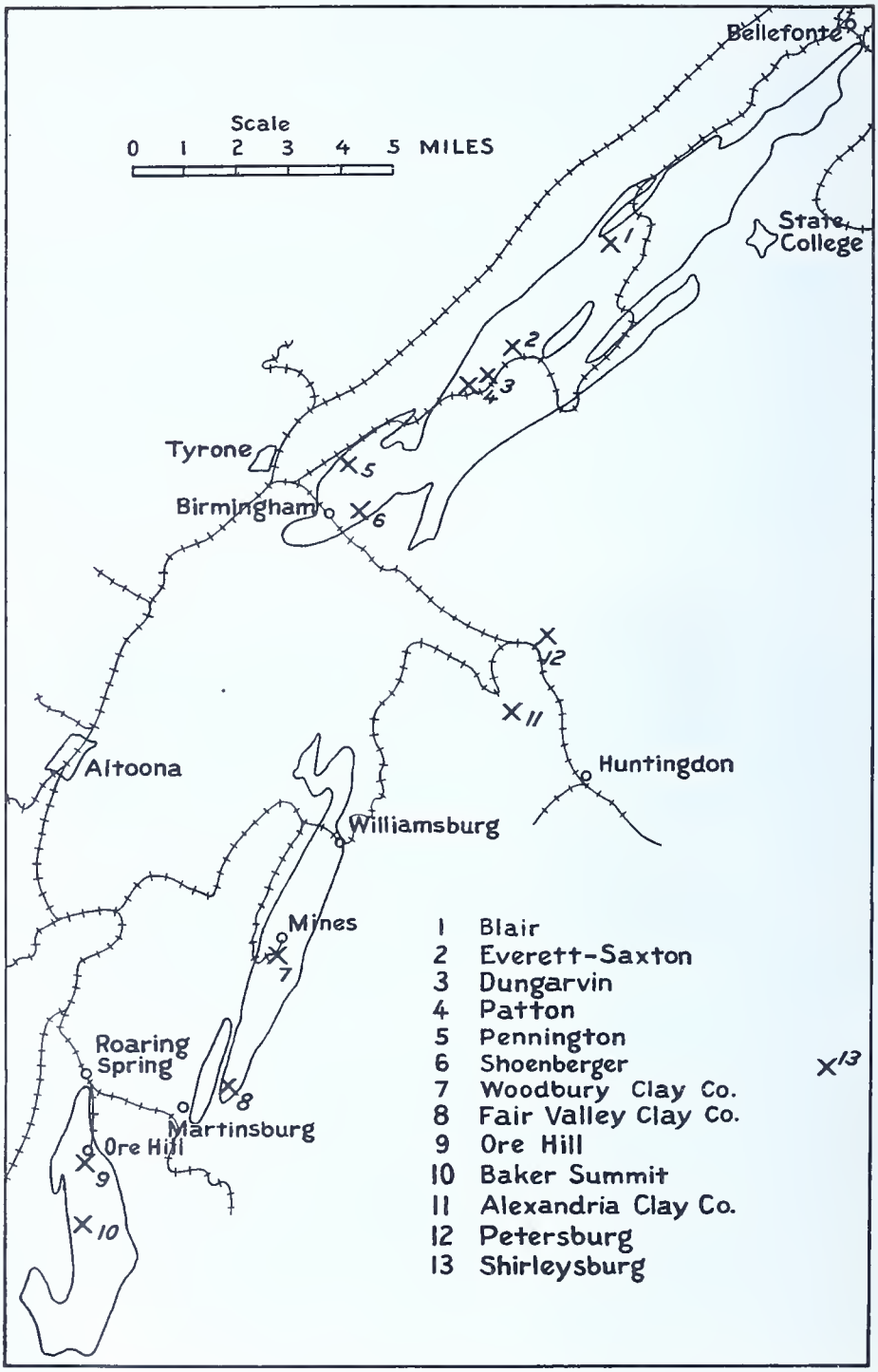

Fig. 3. Map showing 10 white clay deposits in Gatesburg sandstone and 3 in Oriskany sandstone.

FURNACE ROAD. This pit has been known as the Kelsey ore pit, the Gates mine, and the Colonial Clay Co. mine. It is now controlled by the Everett-Saxton Co., 1710 Franklin Trust Building, Philadelphia, Penna. It is located one mile north of Furnace Road station on the Sootia-Tyrone branch of the Pennsylvania Railroad in Centre County. In former years white clay has been excavated from large pits with steam shovels and drag line and hauled to Furnace Run for shipment. In 1927 the railroad discontinued service and no further mining was done. The Bellefonte Central Railroad now controls the branch railroad and promises service. Prospecting is therefore going on in the east end of the pits and drillings show 6 feet of plastic white clay above water level and 16 feet below. The old pits are now filled with water. They were last worked under lease by E. Ellenberger of Pennsylvania Furnace in a pit 75 by 400 feet. Pockets of good clay from 5 to 20 feet thick were worked. The white clay grades irregularly into white sand or into yellowish and pinkish varieties of clay. Tests by Ries[1] show at 1150° C. (Cone 1) an absorption of 28.9 per cent, a hardness not steel hard, and a white color. At 1300° C. (Cone 9) the absorption was 24.8 per cent and the product was steel hard and had a faint cream-white color. In 1922 four to seven cars of clay were shipped weekly its use being chiefly for saggers, and as a cement in Bessemer converter linings, hot metal ladles, and cupolas.

DUNGARVIN. There are several old clay and ore pits near Dungarvin

Fig. 4. Clay pit, Dungarvin, Huntingdon County.

station on the Sootia branch of the Pennsylvania Railroad in Huntingdon County. Pits were opened some years ago under the name of J. T. Throop but in recent years they have been controlled by the Everett-Saxton Co. of Philadelphia and worked under lease by Wm. Lykens of R. D. 1, Warriors Mark. The main pits are just northwest of the station. They cover an area of 600 by 1200 feet and have an average depth of 25 feet. Exposures now show picturesque cliffs and pinnacles of every hue and furnish a fine example of the irregular, pockety nature of these residual clays. The discontinuance of railroad service in 1927 put a stop to the working of the clay. During the war Lykens also took clay from pits south of the railroad.

Tests by Ries[1] are as follows:

---

[1]Ries, H., loc. cit. pp. 96, 97.

Sample 1.
Air shrinkage 6.47%
At cone 8 (1290° C.) linear fire shrinkage 11.76%; absorption 3.8%; color, cream
" " 15 (1430° C.) " " " 11.76%; " 1.9%; " blue-gray

Sample 2.
Air shrinkage 6.47%
At cone 8 (1290° C.) " " " 1.47%; " 16.3%; " cream
At " 15 (1430° C.) " " " .67%; " 15.4%; " tan

PATTON PROPERTY. The clay property owned by Miss Mary Patton of Hollidaysburg lies seventenths of a mile northwest of Dungarvin and was formerly connected with the Scotia branch of the railroad by a short tram when iron ore was mined. In more recent years prospecting has been carried on for white clays by the West Virginia Pulp and Paper Co. and by East Liverpool china-ware interests. Large but irregular pockets of white clay have been encountered under a cover of 5 to 20 feet. One body of clay was 33 feet thick. The clay was said to carry 30 to 40 per cent fine silica but this could be readily washed out. The companies demanded a washed product and the irregular nature of the occurrence probably worked against any large outlay of capital for such a washing plant so that the pits are now idle. There are two well-constructed circular shafts 20 feet in diameter but filled with water; also an old open pit. No very good sample can now be obtained. Ries in his tests made on these clays shows that at 1150° C. (Cone 1) the clay has a porosity of 37.1 per cent, is steel hard and of a white color. At 1300° C. (Cone 9) the porosity was 26.9 per cent, the clay was steel hard and of a cream color.

PENNINGTON PIT. This pit lies half a mile east of Eyer station or one mile southwest of Pennington station on the Scotia branch of the Pennsylvania Railroad in Huntingdon County. It is owned by C. J. McCauley, Second National Bank Building, Altoona, and is worked by Wm. Lykens, R.D. 1, Warriors Mark. The old loading tipple is 1000 feet east of Eyer and the pit 1000 feet southeast of the tipple. The pit shows an overburden of 10 feet of yellow soil carrying small fragments of chert and iron ore. This is underlain by from 5 to 15 feet of plastic white, gray, or mottled clay. The clay is dug by hand, hoisted by derrick and gas engine and since the railroad discontinued service, is trucked 2 miles to a shipping point at Stover. The clay is shipped to steel mills to be used as a cement. Tests of this clay made for the Pennsylvania Topographic and Geologic Survey by Prof. J. B. Shaw in the ceramic laboratory of the Department of Ceramics at State College are as follows:

Firing range 1050° to 1350° C.; green strength low; fired color, buff; use, refractories.

Sample No.	Shrinkage water	Pore water	Slaking in minutes	Linear air shrinkage	Volume air shrinkage	Fusion	Max. lin. fire shrinkage	Modulus of rupture
	%	%		%	%	Cone	%	lbs.
207	9.4	12.3	5	17.7	5.6	29		59
208	6.7	11.6	5	12.8	4.1	30	1.1 at 1200° C.	63

SHOENBERGER PIT. This pit lies 2½ miles northeast of Shoenberger and 2½ miles east of Birmingham in Huntingdon County. It is at the site of the old Dorsey iron ore pits. It is leased by Harry Eckenrode who operates it for Egan and Webster, Grant Building, Pittsburgh. The pit is 25 feet deep and shows 10 to 15 feet of white and gray clay under yellow soil, ore, and chert. The clay is hoisted by a car on an incline, dumped into trucks, and hauled to the main line of the Pennsylvania Railroad at Shoenberger. It is shipped to steel mills

for use as a refractory cement and lining.

A sample was collected by the writer in 1933 and tested by J. B. Shaw at his laboratory in Harrisburg for the Geological Survey in July 1934 with the following result:

Sample No. 421. Shoenberger clay.
Green properties: Plasticity rating, 80; linear drying shrinkage, 8.5%
Fired properties

Cone		1	5	7	9	11
Deg.	C	1160	1205	1250	1285	1325
Linear shrinkage	%	1.5	6.5	11.5	9.5	10.5
Absorption	%	23.7	13.7	3.6	3.6	1.7
Porosity	%	36.3	25.2	8.6	7.4	3.9
Fired color		Cream white				
P.C.E.		Cone 29, 1640° C.				

Uses. A very plastic, white, refractory clay. Useful for production of refractories, pottery, porcelain and paints.

Note: The plasticity rating shows the plasticity and working properties of the clay, as compared with those of well known commercial clays.
100 represents the most plastic American and English ball clays.
90 Good ball clays and the best plastic fire clays.
80 Good plastic fire clays and the best shales and kaolins.
70 Workable shales and fire clays.
60 Short, sandy shales, kaolins and surface clays.
10 to 50 Flint fire clays, semi-flint clays and lean, sandy clays.
Ratings from 70 to 100 represent good working properties.
Ratings from 10 to 50 represent clays of perceptible plasticity but too short to work alone by any wet process of manufacturing.

P.C.E. = Pyrometric cone equivalent.

The above six properties are in the Nittany Valley area of the Gatesburg formation. The next two are in the valley between Williamsburg and Martinsburg, which is bounded on the west by Lock Mountain and on the east by Tussey Mountain. Two properties in the area are active.

WOODBURY CLAY CO. This company operates at Mines Station or Oreminea, 6 miles south of Williamsburg, in Blair County. It is by far the largest operation on the Gatesburg clay. The pit is one mile southwest of Mines Station on the Springfield branch of the Pennsylvania Railroad. The workings form a veritable Grand Canyon some 2000 feet long and 100 feet deep. Operations are conducted with a battery of three steam shovels, and locomotives and trackage carry the clay from the pit to a loading tipple on a standard gauge spur of the railroad.

In the pit, the upper 50 feet is made up of yellowish stony soil and chert with chimneys of white clay extending into it from below. Under this zone there is generally about 10 feet of white chert, then 40 feet of white or tinted clay in irregular pockets. With such large operations and by working in benches the different grades of clay may be kept separate and much of high quality obtained. The clay goes chiefly to steel mills but is said to be suitable also for paper-making, saggers, or white ware, but for these a washing plant would need to be installed. During good times 50 to 75 men are employed.

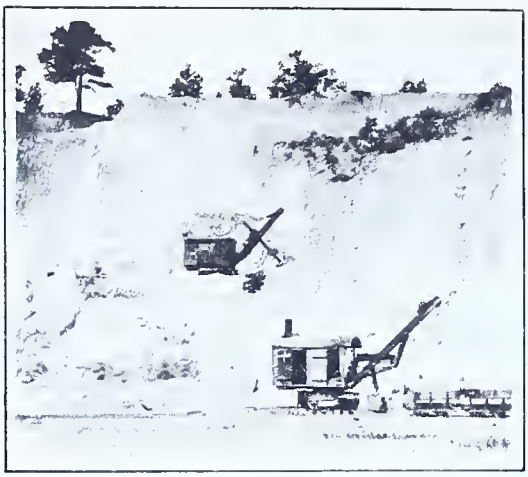

Fig. 5. Clay pit of Woodbury Clay Co., Mines Station, Blair County.

Prof. J. B. Shaw at State College tested three samples for the Geological Survey. No. 211 the best plastic; 212 sandy plastic; and 213 very sandy plastic. No. 211, the best grade, showed a burning range from 1100 to 1350° C. and fired to a light cream. The other grades fired to light to dark buff. The other tests follow:

No.	Water of plasticity	Shrinkage water	Pore water	Slaking	Linear air shr.	Volume air shr.	Fusion	Maximum lin.shr.	Modulus rupture
	%	%	%	Min.	%	%	cone	%	lbs.
211	32.4	9.2	23.2	7	14.4	4.6	29	11.1	9
212	30.6	10.9	19.7	6	17.8	5.6	30	7.1	18
213	22.2	7.5	14.7	7	13.7	4.4	30	2.6	27

FAIR VALLEY CLAY CO. This property is located 2 miles northeast of

Fig. 6. Clay pit of Fair Valley Clay Co., near Martinsburg, Blair County.

Martinsburg in Blair County. It is now leased by A. J. Stormer & Son of Altoona who operate it. The pit is a large one and its walls show many varieties of clay, sand and ore. The clay is dug with a steam shovel and trucked 2 miles to the railroad at Martinsburg. At present (1933) little clay is being dug and they are prospecting a pocket of good plastic clay discovered by drilling and said to show a thickness of 75 feet. A sample of the Fair Valley clay tested by Shaw shows the following: Firing range 1100° to 1350° C., water of plasticity 29.2%, shrinkage water 4.2%, pore water 25.0%, slaking 45 minutes, linear air shrinkage 6.3%, volume air shrinkage 2.1%, fusion cone 27, maximum linear fire shrinkage 5.1% at 1350° C.

The third area of exposed Gatesburg formation lies to the south of Roaring Spring and two openings have been made by Mr. Peter Duncan.

ORE HILL. Peter Duncan of Hollidaysburg for many years operated a clay pit on the site of old ore pits at Ore Hill, 4 miles south of Roaring Spring, with which it is connected by a branch of the Pennsylvania Railroad. The pits are now filled with water and the operations are abandoned, presumably because the good clay became exhausted. In the walls of the pits pockets of varicolored clay and an occasional patch of good clay can be seen. The loading tipple is still maintained to care for the clay hauled for shipment from the newer pit at Baker Summit.

BAKER SUMMIT. Mr. Duncan now operates a new pit 1½ miles southeast of Baker Summit in Bedford County or seven miles south of Ore Hill. This pit is about 200 feet square and 12 feet deep. The overburden varies from 2 to 5 feet and below it there is 7 to 10 feet of good clay. A test pit in the bottom is reported to show 9 more feet of good clay. In all this would make a thickness of 28 feet of clay at that locality. This clay is hauled by truck to Ore Hill and shipped by rail to steel mills.

J. B. Shaw tested a sample at his laboratory in Harrisburg with the following results:

Sample No. 420. Baker Summit clay.
Green properties: Plasticity rating, 70; linear drying shrinkage, 6.5%
Fired properties

	Cone	1	5	7	9	11
	Deg. C	1160	1205	1250	1285	1325
Linear shrinkage	%	2.0	2.5	2.5	2.5	2.5
Absoprtion	%	24.0	23.0	21.8	21.4	21.0
Porosity	%	37.0	36.0	34.0	34.2	33.7
Fired color	White					
P.C.E.	Cone 30, 1650° C. 3102° F.					

Uses. A very white refractory clay, useful in the production of refractories, pottery, porcelain and paints.

See note on page 7.

Residual clays from the Oriskany sandstone

Like the Gatesburg formation the Oriskany sandstone of the Lower Devonian in places weathers into masses of white to gray clay. In these central counties the Oriskany is divided into an upper zone of heavy-bedded, coarse sandstone about 100 feet thick and a lower zone of chert (the Shriver chert) and shale (the Stormstown shale). These are about 200 feet thick, an unusual thickness for this lower member. The clays seem to develop by weathering of the cherty portion and some of the shaly beds. The coarse upper member gives to the Oriskany a prominent outcrop forming rocky ridges and in some places where the

dip is nearly vertical producing the so-called "pulpit rocks". The clay pockets should be found dipping under these coarse sandstones. Although all the counties in question have outcrops of the Oriskany, its clays have been worked at only three localities, all in Huntingdon County.

ALEXANDRIA FIRE CLAY CO. This company under the direction of G. I. Phillips operates a white clay pit 3 miles southeast of Alexandria along the old Philadelphia Pike. It is located on a wide ridge of Oriskany sandstone known as Warrior Ridge. The pit has a high west wall of the Upper Oriskany sandstone

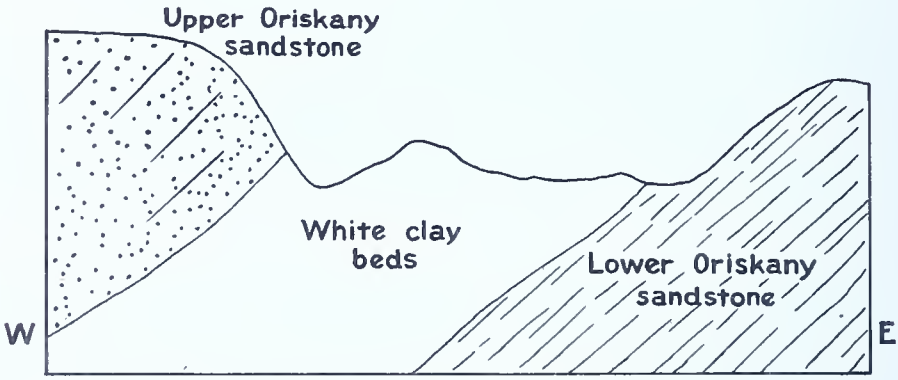

Fig. 7. Cross section of clay pit near Alexandria, Huntingdon County.

Fig. 8. Clay pit of Alexandria Fire Clay Co., 3 miles southeast of Alexandria, Huntingdon County. Clay dips under Oriskany sandstone in background.

dipping steeply west; a central zone of white clay carrying chert and some shale and dipping steeply beneath the heavy sandstone. This zone is about 50 feet wide and is the minable material. The east wall consists of shale representing the lower Oriskany. (See Fig. 7.) It is not weathered to clay and is not used.

The clay as mined is a fine-grained, white to gray, siliceous clay carrying impressions of trilobites and brachiopods, an unusual feature in residual clays. The east face of the clay zone was being worked in 1933 with a face about 30 feet wide and 30 feet high. The clay is dug with steam shovels, trucked 2 miles to the south end of Alexandria where the company has a plant equipped with a rotary drier, KV hammer mill for crushing the clay, chert and shale, and large storage bins. The crushed clay is shipped to steel mills. The company maintains a large production and estimates that they still have in sight some 250,000 tons of good clay. The clay was first worked by Sam Hatfield for use in a local iron furnace; latter it was shipped by way of the Pennsylvania Canal to the Barree Furnace.

The following tests were made by Shaw[1]:

Water of plasticity	29.94%	Slaking time, minutes	6
Shrinkage water	8.92%	Drying volume shrinkage	14.17%
Pore water	21.02%	Fusion, Cone 28 or 1635° C.	

Degrees C.	1000	1050	1100	1150	1200	1250	1300	1350	1400
Volume burning shrinkage	0	0	1.96	5.43	9.58	9.77	11.22	12.42	5.56
Porosity	35.6	34.7	36.1	35.9	30.3	31.2	28.8	26.6	27.5
Apparent specific gravity	2.44	2.49	2.49	2.70	2.49	2.45	2.48	2.44	2.28

Shaw states that this is a siliceous clay with good burning properties; satisfactory as cement in silica brick laying but not to be used as a refractory where basic ash or slag is encountered.

PETERSBURG. The Alexandria Fire Clay Co. owns a pit 300 feet north of Petersburg and up a steep plane. This property is no longer in use as the clay was colored. It also is weathered Oriskany material. This pit was described by Peck[2] as follows:

> " The beds strike N.60°E. and dip 25°SE., and the main face of the quarry shows a thick deposit of residual clay overlain by sandstone. The clay is probably derived from the shaly limestone of the Shriver formation, the basal formation of the Oriskany group in this area, and the sandstone over it is the Ridgely sandstone, the upper formation of the Oriskany group. A sandy shale, which also belongs to the Shriver formation, lies between the limestone and the sandstone. There is no white clay here, as at Saylorsburg, and the material is all reds or black. It is ground before shipment, but the uses are not known."

SHIRLEYSBURG. This property was formerly known as the Rock Hill Clay Co. but in 1930 it was purchased by Harbison-Walker Refractories Co. and is now known as the Walker mine. The pit is located 1½ miles southeast of Shirleysburg, in Huntingdon County. It was formerly connected with the East Broad Top Railroad by a tram but now haulage is by truck to a loading station at Shirleysburg. The coarse upper Oriskany sandstone outcrops near by and it is apparent that the clay here is the weathered product of the lower Oriskany shales, although it may represent the Marcellus. The shaly nature has been preserved in the clay and it shows a steep west dip. In 1933 a 10-foot face of smooth blocky gray clay was worked. It differs from the Alexandria clay in having no grit or chert fragments and in being darker and showing distinct shale laminations.

---

[1]Shaw, J. B., Fire clays of Pennsylvania: Pennsylvania Topo. and Geol. Survey, Bull. M10, 1928.

[2]Peck, F. B., High-grade clays of the eastern United States: U.S. Geol. Survey, Bull. 708, p. 115, 1922.

Operations are conducted by a few men with mule haulage but a steady production is maintained, the clay going to the Harbison-Walker Refractories Co. plants. In former days clay was shipped to the Atlanta Terra Cotta Co. and to rubber firms. It is now used for furnace linings, fire brick cement, and other refractory purposes. Tests made by J. B. Shaw for the Geological Survey are given below; sample No. 205 a white clay and No. 206 a blue clay although it is not practical to separate them.

	Sample 205	Sample 206
Plasticity	good	good
Green strength	high	high
Fired color	light buff brown	light cream to dark buff
Burning range	1100° to 1250° C.	
Water of plasticity	39.8%	60.5%
Shrinkage water	11.2%	13.8%
Pore water	28.7%	46.7%
Volume air shrinkage	14.2%	20.8%
Linear air shrinkage	4.5%	6.5%
Fusion	Cone 27	Cone 27
Maximum linear fire shrinkage ..	12.3%	14.2%
Maximum shrinkage reached at ..	1350°C.	1300°C.

MOUNT HOLLY SPRINGS REGION, CUMBERLAND COUNTY

South and southwest of Mt. Holly Springs lies the mountainous belt known as South Mountain, rising 800 feet above the surrounding lowlands. This mass is made up of a core of pre-Cambrian crystalline rocks flanked by folded and faulted Cambrian strata, chiefly quartzites and phyllites. Deep weathering of the thinner-bedded quartzites and of the phyllites has yielded white and gray residual clays of value.

The principal area of development has been one to two miles southwest of Hunters Run or 5 miles south of Mt. Holly Springs along Mountain Creek. Mountain Creek here flows along the strike of a synclinal belt of the Tomstown dolomite of upper Cambrian age. Northwest of the creek the mountain rises steeply and is made up of Antietam quartzite and Harpers phyllite dipping to the southeast. Farther up and farther into the mountain the more resistant Montalto quartzite lies below the other beds. The residual clays lie on the lower slopes of the mountain under a cover of mountain wash and colored clays. Driving entries into the mountain discloses first the colored clays, then the good white varieties and finally a foot-wall of quartzite which may be the resistant Montalto beds.

Two companies operate mines in the Hunters Run area. The most northern is the mine of the Philadelphia Clay Co. This mine lies one mile southwest of Hunters Run, at Toland or Gardners, and on the west side of the creek and railroad. The mine entry cuts directly into the mountain side for 150 feet then headings are driven off to the northeast and southwest along the strike of the clay bed. It is said that they have 65 feet of clay above the main entry and enough for two lower levels. The clay is trammed by mule and locomotive to a well-equipped washing plant near the mine mouth. It is washed and shipped by way of the Hunters Run and Slate Belt Railroad, to paper mills. The crude clay is white and plastic. It carries a few limonite stains, and nests of coarse silica and a few quartzite pebbles and boulders. All of this can be readily removed by washing but there is some finer silica which is difficult to remove. The iron content rarely is more than one-half to one per cent. Tests made by Shaw on the crude clay from the bins show it to have very good plasticity, a low green strength and to fire to a light cream to light gray color. Its burning range for vitrified ware is 1200 to 1250° C. and he suggests that it could be used for a cream body as it is, and for white body if refined. His further tests are as follows:

Water of plasticity	35.9%	Volume of air shrinkage	13.3%
Shrinkage water	8.9%	Linear air shrinkage	4.3%
Pore water	27.9%	Fusion, Cone 20	
Slaking time, minutes	26	Modulus of rupture, lbs.	27

Maximum linear fire shrinkage 10.8% at 1250° C.

The Medusa Portland Cement Company mine (formerly the Sandusky Portland Cement Co.) is located three-quarters of a mile southwest of the Philadelphia mine and on the same ridge. Their entry extends 580 feet down a steep incline, then flattens out into side headings. Their clay shows a more schistose structure than that at the Philadelphia mine. It is white to gray in color, and is shipped without refining, to the cement plant of the company at West York, Pa. where it is used to whiten the portland cement. Tests made by Ries[1] on this clay are as follows: "Fired at 1150° C. it showed 6.4% absorption and 15.9% porosity. Fired at 1300° C. it had 0.1% absorption and 1.2% porosity. It burned buff at the lower temperature and was steel hard. At the higher temperature it burned gray."

The only active opening in the Mount Holly Springs region in 1933 is a prospect being opened by G. N. Gouchnour on his land three-quarters of a mile west of Mount Holly Springs on the northwest slope of South Mountain. He has driven several monkey drifts and shafts and claims to have found 30 feet of clay in a shaft and 30 feet additional footage in some drilling, and claims that this bed has been proven horizontally for 200 feet. The clay is apparently a good grade of white plastic clay. Some years ago on the property adjoining his on the west and owned by Mr. Nickey, clay was taken out and used in making white brick and chimney brick at the plant of the Mount Holly Brick Co. at Mount Holly Springs. Mr. Goodyear, whose land adjoins the Gouchnour property on the east, also mined residual clay at one time, selling a manganiferous clay to the Asper Tile Co.

There are several clay properties in the Mount Holly region which were once active but have long been abandoned. They probably worked out the clay or ran into too much sand. Some built quite elaborate washing plants before recognizing the irregular, pockety nature of such residual clays. Descriptions of these plants are given fully in Bulletin 708 of the United States Geological Survey. Abstracts from this bulletin are given below:

The Cumberland Clay Co. operated a large deposit about 1 mile east of Upper Mill. It has long been abandoned and the property now (1933) is owned by John Fahnestock of Mount Holly Springs.

The Henry Clay mine. This mine was near the town of Henry Clay, 2 miles southwest of the Medusa mine. It was worked by tunnels and shafts and the clay was sent to the Mount Holly Brick & Clay Co. at Mount Holly Springs.

The Holly Clay Corporation had a large open pit operation on the northwest side of South Mountain, 2 miles east of Mount Holly Springs and 2000 feet south of the Philadelphia & Reading Railway. The pit showed 15 feet of overburden and 12 to 15 feet of clay. The clay was grayish white, mottled with limonite in places. It carried streaks of white sand and angular lumps of quartzite. The crude material was passed through a log washer thence into a short trough to separate the stones from it. It then was sent to a Dorr classifier and then the clay and water were taken by pipe line to the washing plant where the mixture was passed through a Dorr hydroseparator, 50-foot sections of trough, a Dorr thickener, a filter press, and dryer. Sodium carbonate was added in the log washer to deflocculate the clay and sulphuric acid to neutralize the alkali as the clay left the trough. The plant is said to have had a capacity of 60 tons of washed clay in 24 hours.

---

[1]Ries, H. loc. cit. p. 86.

Tests of the clay are as follows:

	Crude		Washed	
Temperature (°C.)	1150	1300	1150	1300
Absorption (per cent)	3	0.5	8.4	1.5
Porosity (per cent)	10	2	19.5	3.4
Color	Buff	Gray	Cream-white	Gray-buff
Hardness	Steel hard	Steel hard	Steel hard	Steel hard

Tests of a washed sample showed linear air shrinkage 2.26%. At Cone 8 (1290°C.) linear fire shrinkage was 14.12% and color grayish white. At Cone 15 (1430°C.) linear fire shrinkage was 10.15%, the absorption 0.6% and the color grayish white.

This plant in 1933 was entirely abandoned. According to local report the pit ran into too much sand.

DILLSBURG REGION, YORK COUNTY

The South Mountains extend east from Cumberland County into western York County west and southwest of Dillsburg. Two to three miles west of Dillsburg along Dogwood Run clays similar to those of the Mount Holly region are to be found. They represent the weathered residual clays derived from the Antietam quartzite and the Harpers phyllite of the Cambrian period. Two properties have been worked along the run. The Russell property lies on the York-Cumberland County line about 3 miles above Beavertown or 4 miles west from Dillsburg. This property was last worked by the Kaolin Corporation of America but has been idle for many years. Tunnels were driven into the mountain side and both colored and white clays were found. A washing plant was built half a mile west of Dillsburg and a tram road connected the mine with this plant. The reason for the abandonment of the operations is not clear.

The second mine along Dogwood Run is that of Mr. Fishel of Dillsburg. This mine lies on the south side of the run and about 1½ miles above Beavertown. The mine consists of two tunnels now inaccessible. Mr. Fishel states that he has in the mines a face of about 30 feet of clay. The mine in the past has supplied clay to the Central Iron & Steel Co. of Harrisburg and to the Penn Tile Works Co., Aspers, Pa. It is suited to the manufacture of tile, linoleum, matches, and for refractory cement in steel mill work. The clay when mined is hauled by truck to Dillsburg. Mr. Fishel is experimenting with the white clay and with colored clays in the manufacture of shingles, blackboards, roofing tile and other hard tile products without burning. The clay, coloring matter and some hardener are mixed and after setting, make a hard durable product.

NARVON, LANCASTER COUNTY

This area of residual clays lies along the north slope of Welsh Mountain in eastern Lancaster County, 4 miles west of Honeybrook. Welsh Mountain is made up of resistant Chickies quartzite of Lower Cambrian age. The upper portions of the Chickies are thinner bedded and weather to a white clay while above this lies the Harper phyllite, a greenish schist which weathers to a speckled gray clay. Two companies are working the clays of the ridge at Narvon.

The Whitaker Clay Company, operating here since 1902, has a pit about 1000 feet southwest of the station on a switch from the Pennsylvania Railroad. The pit is cut into the north slope of the ridge and the beds dip southeast 30°

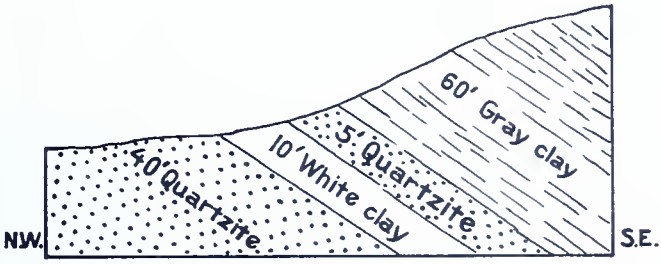

Fig. 9. Cross section of Whitaker Clay Co. pit, Narvon, Lancaster County.

into the ridge (see Fig. 9). At the entrance to the pit, quartzites carrying a 10-foot bed of white clay are to be seen but in the quarry these give way to a main clay bed about 60 feet thick. The main clay is gray and speckled and shows a schistose structure. It carries some sandier layers and some quartz veins. It is probably derived from schistose phases of the upper Chickies quartzite or from the overlying Harpers phyllite. The thinner, whiter bed in the quartzite is probably derived from the weathering of feldspathic quartzite. Tests made on the main clay show that it has 2.26% air shrinkage[1]. At cone 8 (1290°C.) its fire shrinkage is 10.79%, its absorption 1.3%, and its color buff. At cone 15 (1430°C.) it is overfired. This indicates that it is not suitable for china manufacture. It is sold extensively to steel mills and for filler in linoleum and other products. The company has a well-equipped grinding plant which loads directly into railroad cars (see Fig.10).

Fig. 10. Whitaker Clay Co. mill, Narvon, Lancaster County.

[1]Ries, H., loc. cit., p. 90.

The Diller Clay Co. operates a similar pit about 2000 feet west. Their pit also cuts into the quartzite and schist of the ridge but the structure is less evident and more complex. In 1933 they were working a 25-foot face of massive gray clay. The clay is dug by hand and shoveled on a long belt which conveys it to the rotary cylindrical dryer at the mill. The clay passes through a well-equipped pulverizing plant and is shipped in sacks. It is used in steel mill practice, in molding compound for foundry use, and as a filler. Operations began here about 1914.

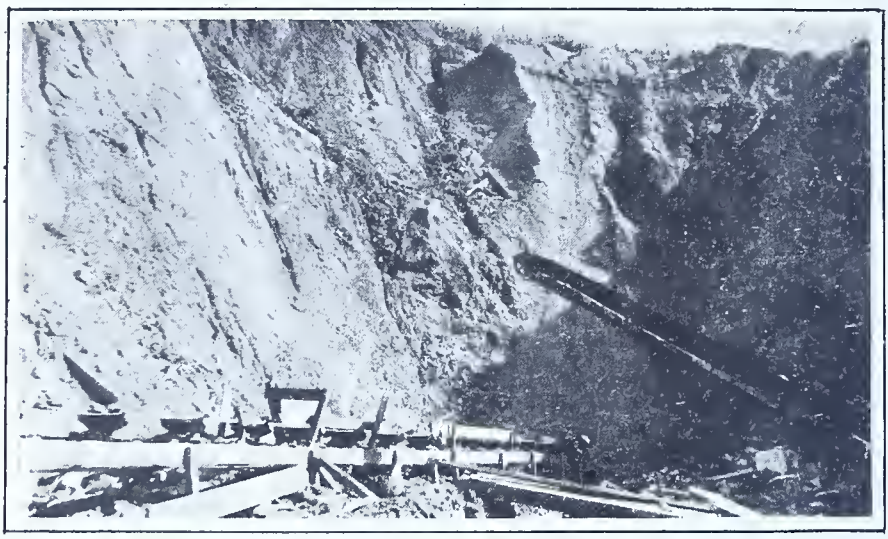

Fig. 11. Diller Clay Co. pit, Narvon, Lancaster County. Belt conveyor carries clay to mill.

Sample No. 419. Narvon white clay, Diller Clay Co.
Green properties: Plasticity rating, 60; linear drying shrinkage, 4%.
Fired properties

Cone	1	5	7	9	11
Deg. C	1160	1205	1250	1285	1325
Linear shrinkage %	1.0	4.0	6.0	7.0	9.0
Absorption %	27.1	18.4	13.8	11.1	6.3
Porosity %	40.3	30.0	24.5	24.0	12.4
Fired color	Dark gray				
P.C.E.	Cone 26. 1595° C.				

Uses. A very white clay, containing a high percentage of free silica in a finely divided form. Its dry strength is very low and it fires to a dark gray color. It may be used as a No. 2 refractory or filler for paint.

See note on page 7.

The Walters property mentioned in earlier reports has never been opened up. It lies half a mile west of the other properties.

Northeast from Saylorsburg is a prominent ridge known as Cherry Ridge. It is made up of steeply tilted Oriskany sandstone and the underlying Stormville shale and Bossardsville limestone. The beds dip into the hill to the southeast. Southwest from Saylorsburg a similar ridge, known as Chestnut Ridge, has essentially the same structure. The shaly limestones and shales underlying the coarse Oriskany sandstone along these ridges are deeply weathered to a residual clay, the different layers showing clays of different colors. Some of the beds are carbonaceous and black, many are gray, a few are very white. The dip of the beds is generally about 30 to 60° toward the south or southeast so that an entry driven into the ridge cuts across the beds and eventually reaches the overlying Oriskany sandstone as a hanging wall.

Present operations. The Atlas Portland Cement Co. alone operates in the district at present and their product is a white, siliceous clay which is used by them to whiten their portland cement. They are said to have drilled most of the two ridges and to control most of the good clay deposits between Saylorsburg and Kunkletown. Their earlier operations were confined to an area 1 mile northeast of Saylorsburg on Cherry Ridge. Here the company has sunk several shafts and cross-cut from them toward the ridge, exposing many good beds

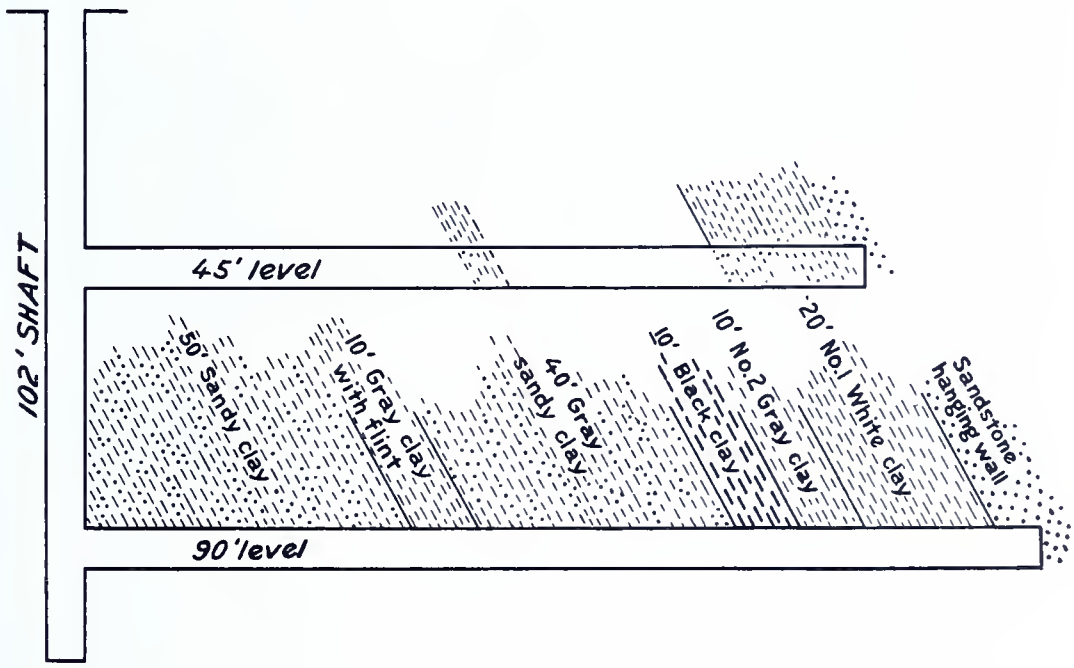

Fig. 12. Generalized section through mine of Atlas Portland Cement Co., Saylorsburg, Monroe County.

of clay (see Fig. 12). In 1933 the shafts were idle and the company was using up a very large stock pile near by. The best clay was the bed directly under the hanging wall of Oriskany sandstone. It had a width of about 20 feet. The clays are loaded on a branch of the Delaware, Lackawanna, and Western Railroad 0.3 mile west toward Saylorsburg. The workings as they were in 1922 are described by Peck[1].

[1]Peck, F.B. White clay deposits at Saylorsburg, Monroe County, Pa.: Pennsylvania Topo. and Geol. Survey, Bull. 40, 1922.

Tests of the crude clay made by Ries[1] show at 1150° C. an absorption of 12.8%, a porosity of 1.6% and a buff color. The product was steel hard. At 1300° C. the absorption was 31.2%, the porosity 2.9% and the color light gray.

The other property of the Atlas Portland Cement Co. is at Kunkletown, 8 miles west of Saylorsburg. This is now their main property. Mining is in open pits on Chestnut Ridge south of the railroad and 300 to 500 feet above it. Their old pit is 1 mile south of Kunkletown and their newer pit half a mile southeast of the station. In 1933 they were extending the tracks from this pit several miles east along the ridge to open up new clay lands. Mining is done by steam shovel and drag line. The clay is trammed a quarter of a mile to a tipple where it is loaded into trucks for haulage to the railroad below. The Kunkletown clay being from open workings is not so carefully handled or as clean as the Saylorsburg clay. It is therefore stonier and has more iron stain. It is usually mixed 40 per cent with 60 per cent Saylorsburg clay. All of the Atlas clay is shipped crude to their cement plants for making white portland cement.

Earlier operations. In earlier years the clays of the Saylorsburg region were exploited much more extensively and used for a number of purposes. In the anticipation that some of the industry may be revived it seems well to review the earlier history and development as recorded by Peck[2].

The first development of the white clays was in 1891 when Oscar Drehr built a plant in Saylorsburg and attempted to make enameled brick but with little success. In 1894 Blanchard Bros. of Newark, N. J. took over the plant and made for some years, dry pressed brick. The plant at one time employed 150 men. It changed hands several times and in 1908 the Keystone Clay and Reduction Co. began operating it for the production of washed clay. In 1919 this company was hoisting about 60 tons of clay daily from a number of shafts in the heart of Saylorsburg and producing about 30 tons of washed clay. Most of the clay went to the New England paper mills. Some was shipped to rubber companies and some to the manufacturers of water paints. The plant was well equipped, the clay passing through a special pug mill, then into a trough where caustic soda was added to deflocculate it. Thence it passed into large settling tanks and into troughs where the fine sand settled out. The fine clay and water then went into a large tank where alum was added again to deflocculate the clay. The precipitated slip then passed into filter presses and driers and was ready for shipment. The annual production was about 7500 tons.

The shafts ranged from 45 to 116 feet deep. In one, a drift from the shaft bottom cutting southeast passed through the tilted strata as follows: 20 feet black clay, 50 feet No. 2 gray clay, 30 to 36 feet No. 1 white clay. Overlying the white clay is the hanging wall of Oriskany sandstone.

Tests made on the clay are as follows:

	°C	Absorption	Porosity	Color
Washed clay	1150	1%	5.9%	Buff
	1300	0	0.4%	Gray-buff
Second grade crude	1150	8.6%	21.9%	Buff
	1300	0	0.5%	Gray-buff

The air shrinkage was 3.42%; at cone 8 (1290°C) linear shrinkage 11.97%, absorption 0, color grayish white; at cone 15 (1430°C.) it was overfired.

The last name for the company was the Blue Ridge Clay Co. At present (1933) the

[1]Ries, H., loc. cit. p. 113.

[2]Peck, F.B. White clay deposits at Saylorsburg, Monroe County, Pa.: Pennsylvania Topo. and Geol. Survey, Bull. 40, 1922.
The Saylorsburg District: High grade clays of the United States, U. S. Geol.Survey, Bull. 708, pp. 109-115, 1922.

buildings are practically demolished and the shafts are completely buried under village development.

The Mt. Eaton Clay Co. began operations west of Saylorsburg in 1917, later becoming the Pennsylvania White Clay Mining Co. Their mines and plant were located 1½ miles southwest of Saylorsburg on the north slope of Chestnut Ridge. Their original shaft was 100 feet deep, sunk in sandy flint. A 200-foot crossout driven off at the 85-foot level passed through the following dipping strata:

50	feet	gray sandy clay
10	"	good gray clay
60	"	gray sandy clay
6	"	good white clay
6	"	clay with flint
15-18	"	No. 1 white clay, mined
51	"	gray clay to hanging wall of heavy sandstone

In 1922 two new shafts had been dug and the company was mining 50 tons of clay per day. The clay was ground and sold as a semi-refractory clay for foundry, blast furnace, and general metallurgical practice. Washing was abandoned as the yield was only about 25 per cent. Two analyses of the clay are as follows:

	Sample 1	Sample 2
SiO_2	69.85	67.89
Al_2O_3	22.53	21.57
Fe_2O_3	1.23	1.60
CaO	1.17	0.78
MgO	0.35	0.50
Alk.	1.06	1.00
TiO_2	-	1.90
Moisture and undetermined .	3.90	4.76

This company is no longer in operation.

Operations began at Kunkletown 50 years ago with the discovery of white clay on the north side of the ridge. It was first used in soap manufacture. Later the New York and Pennsylvania Brick and Tile Co. and still later the Chestnut Ridge White Clay Co. made white brick at Kunkletown. The following tests on the Kunkletown clays are given in U.S. Geological Survey Bulletin 708.

Crude clay from bottom of old pit showed 16.6% absorption at 1150°C. and 2.6% absorption at 1300° C. Another test of the crude clay showed at 1150°C. absorption 12.0, porosity 27.5 and a buff color. At 1300° C. it burned gray and showed no absorption or porosity.

Tests from the Pennsylvania Geological Survey were as follows:

Sample	Air shrinkage	Cone 8 (1290°C) Linear fire shrinkage	Cone 8 (1290°C) Absorption	Cone 8 (1290°C) Color	Cone 15 (1430°C.) Linear fire shrinkage	Cone 15 (1430°C.) Absorption	Cone 15 (1430°C.) Color
	%	%	%		%	%	
1	2.84	3.41	9.7	Cream	6.57	9.2	Buff
2	2.26	12.42	0	Gray-white	Overfired	.8	
3	3.42	11.97	0	" "	"	--	

It will thus be seen that a great deal of white and light-gray clay has been mined in the Saylorsburg-Kunkletown region and that it has been used for a wide range of purposes. How much good clay still remains along the ridge is problematical but if new deposits can be found some of the various industries might be revived.